

75
1175
A45
no. 1806

ENGINE STORAGE
Engineering

Allis-Chalmers

Manufacturing Company

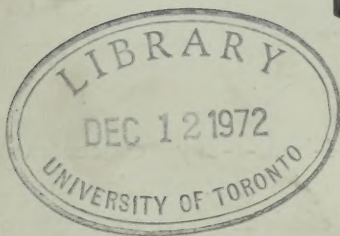
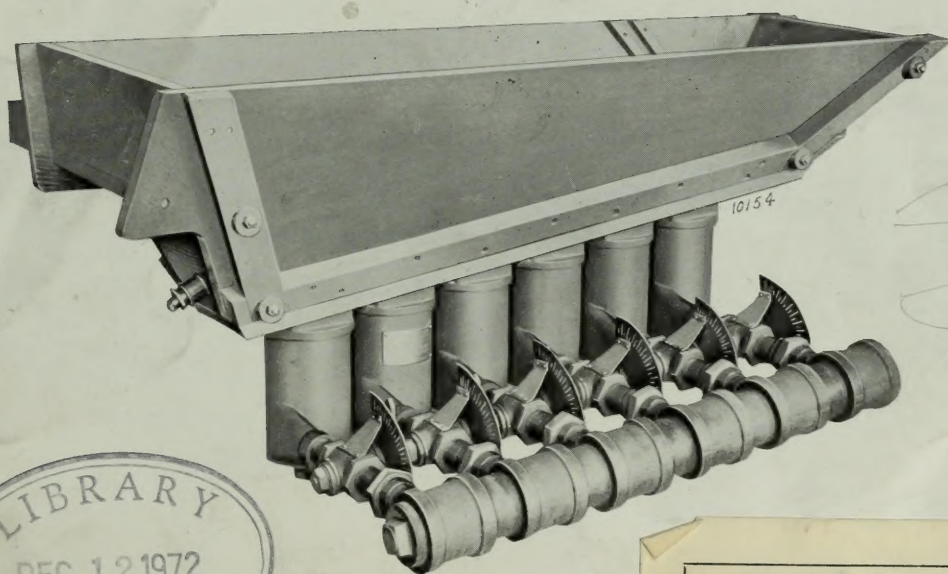
MINING MACHINERY DEPARTMENT

Bulletin No. 1806

November, 1913

The Richards' Hindered Settling

Plate 10154



CLASSIFIER

Catalog No. 1348

Year of Issue 1913

Please return to

Section No. A-6-3

Catalog Library
Department of Mining Engineering

Copyright, 1913

MILWAUKEE, WIS., U. S. A.

By Allis-Chalmers Mfg. Co.

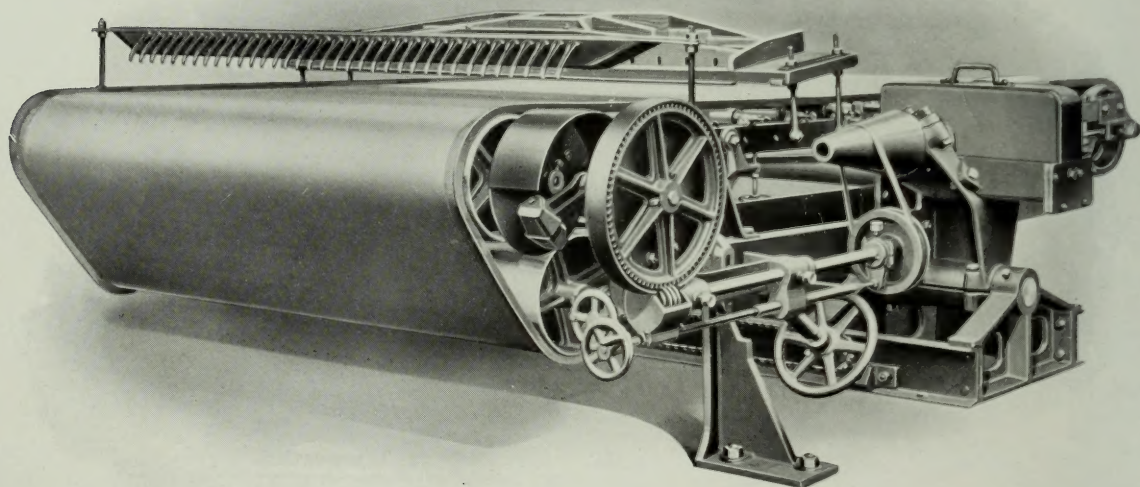
MAINTAINING CAPACITY

is especially important in the concentrating plant.

In order to keep a plant running up to full capacity, the equipment must be of a kind that will operate with a minimum amount of wear and shut-downs for repairs.

A concentrating plant equipped with classifiers and vanners, these being the most important part of the equipment, must be kept in a high state of repair to insure the highest efficiency. There are no two machines used in a concentrating mill that will cause less shut-downs for repairs and cost less for up-keep than our Isbell Vanners and Hindered Settling Classifiers.

-Plate 10616



The Isbell Vanner (patented) is a successful 24-hour-a-day concentrator requiring little attention and few repairs. Its motion makes the concentrating surface of greatest effectiveness and it is without question the most efficient slime concentrator of the present day.

Your operations will be greatly improved when you install this vanner.

Send for Bulletin 1801—ISBELL VANNERS

THE RICHARDS' HINDERED SETTLING CLASSIFIER

(Patented)

The modern concentrating mill beneficiating large tonnages of low grade ores owes much of its success to the ability to handle both the fine material formed in the ordinary process of crushing and the fines from the regrinding of particles containing included grains of ore.

Concentration of fine material takes place upon some form of surface machine: buddle, vanner or table. The saving made with these machines is determined largely by the preparatory treatment given the ore pulp before going to them; it is in the preparation of the ore pulp that the classifier finds its field.

The study of the laws of mechanics underlying all concentration using gravity in any way show that at least two variables enter into the problem: size (diameter) and weight (specific gravity). No single machine yet constructed having the ability to effi-

Plate 10187

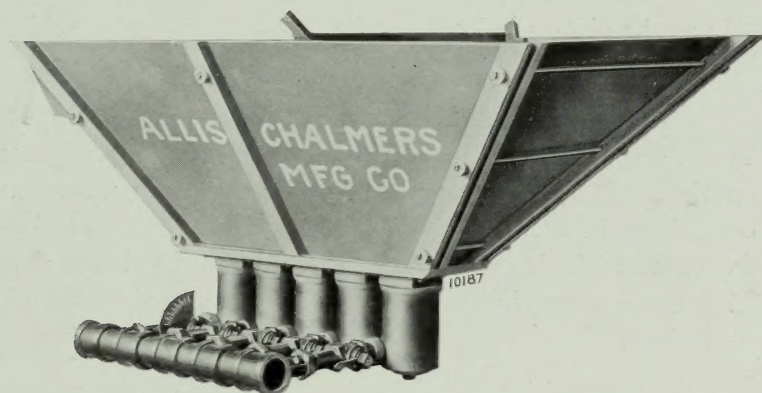


FIG. 1. RICHARDS' HINDERED SETTLING CLASSIFIER—FIVE SPIGOT

ciently separate the concentrates from a mass of material containing all sizes of all specific gravities, it follows that the art of fine concentration involves the use of a number of machines each making a product within definite limits as to size and weight, the final result being the separation of the more or less smaller quantity of valuable concentrates from the usually greater quantity of valueless gangue. These principles are well understood by operating mill men.

Concentration on surface machines usually depends on a combination of several principles such as: free or hindered fall in water, pressure due to the surface velocity of a moving film of liquid, friction resisting the rolling or sliding of a body, percussion, capillary action, etc.; but the action of the classifier is usually based upon the one simple principle

of the selective effect on the ore particles of a free or hindered fall in a medium, usually water. The results of this selective effect may be stated as follows: of two bodies of equal diameter falling in water the heavier will fall faster, or farther in a given time, as,

Plate 10162

G

• D

○

○

○

○ F

C

○

•

QUARTZ

○

•

○

•

GALENA

○ B

E

•

•

•

•

A

FIG. 2

as an equal sized particle of quartz "B"; of a series of bodies of varying size but of the same specific gravity the largest will fall fastest as "A" in "AEC", and as "B" in "BFD", shown in Figure 2; of two series of bodies of varying size and different specific gravity, there will be mates of equal falling particles, smaller heavier particles paired with larger particles of the lighter material, as "EB" and "CF". Within the limits of size usually treated in fine concentration, the ratio of the diameters of paired particles falling equally under equal conditions is practically constant and is a function of the specific gravity. This condition holds for any number of series of particles differing in specific gravity, the ratio, of course, being constant between two specific gravities.

In the earlier classifiers, first crude in design and later more scientific as the principles began to be understood, the principle of free settling in water was used.

Professor Robert H. Richards of the Massachusetts Institute of Technology, who for years has been the leading investigator and authority on the subject, has determined under falling in water and free settling conditions the ratios of the diameters of the commoner economic minerals compared with those of quartz, this relationship being shown in Figure 3. This figure also shows the ratios of diameters under hindered settling conditions.

The recognition by Professor Richards of the principle of hindered settling, its investigation and application, stands out as one great advance in the art of concentration within the past decade.

Hindered Settling, as its name signifies, is the settling of ore particles through a medium (water) in effect made denser by the suspension of similar particles in a rising current, no particle passing except it be greater in size or specific gravity than the particles hindering its fall. Hindered settling has the same effect as if a liquid of a density up to 1.5 were used instead of water; according to Rittinger's law, the ratio of diameters of equal falling particles varies as the square of the density of the liquid, so that hindered settling more than doubles this ratio as tests will show.

On concentrating machines treating **unclassified feed** certain particles of gangue both small and large will be found to follow the same course as the concentrates and

contaminate them, and certain particles of the economic minerals will follow the course of the gangue into the tailings; the attempt to increase capacity serves to increase the evil.

With **classified feed** the particles of the same specific gravity are of practically the same diameter and differing from those of different specific gravity, which distinction on some type of surface or sizing concentrator permits a better separation of the heavy minerals from the lighter and larger gangue.

The advantage of **hindered settling classification** is that the difference in size between the gangue and the economic minerals is much greater, allowing them to separate farther apart on the table, or allowing the much smaller sized particles which will compose the

Plate 10166

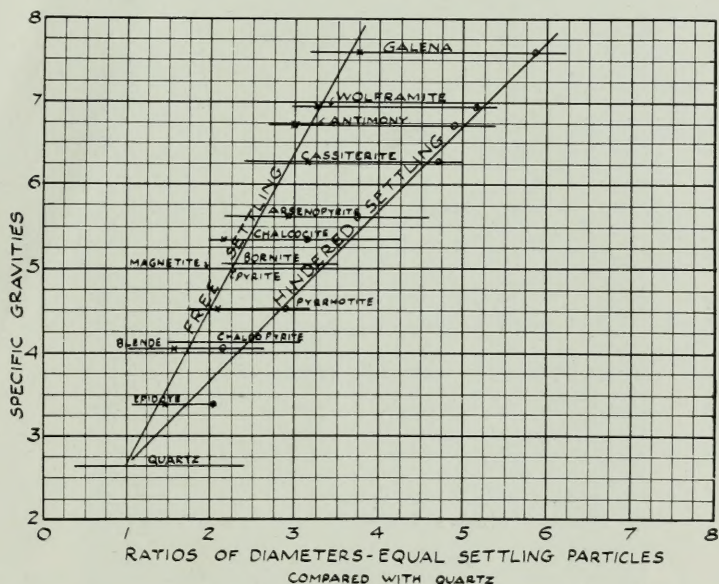


Fig. 3

concentrates to lay more evenly on and to stick closer to the surface of the vanner or buddle during washing. This not only results in a cleaner separation, but will allow loading the machine to a much greater depth before the different minerals commence to intermingle. Not only does hindered settling improve the quality of the concentrates and decrease the tailing losses, but the quantity of the middling produced will be much smaller.

The character of the work done by both free and by hindered settling classification is shown in Figures 4 and 5, the former showing the result of screen sizing the different spigot products from a free settling classifier and the latter the same thing from a hindered settling classifier. The dark particles are galena and the light quartz, each vertical column being the result of screen sizing the product of a single classifier spigot. It will be noticed that there is a well defined valley in the case of the hindered settling products,

Figure 5, between the galena and the quartz, indicating that separation into concentrate and tailing can easily be accomplished with the making of but little middling. On the contrary, Figure 4 shows no such valley, indicating that in making the separation of a clean concentrate from a clean tailing a considerable amount of middling is produced which must be re-treated, or else some of the middling must be taken with the concentrate and some with the tailing, resulting in an undesirably lower grade of concentrates and higher tailing losses.

Plate 10235

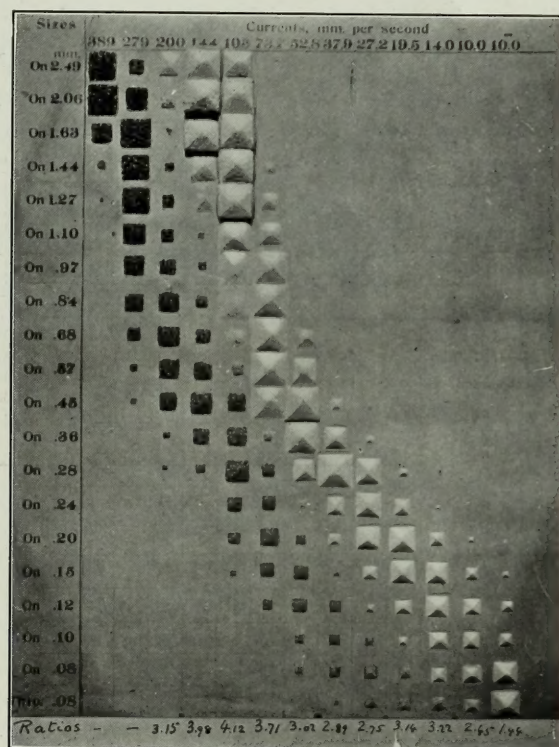


FIG. 4. FREE-SETTLING

Hindered settling is effected in the Richards' Hindered Settling Classifier (Figure 6) by introducing a constriction in the lower part of the sorting column through which all classified particles and the rising water pass in opposite directions. Above the constriction there is a mass of particles in "teeter" or suspension, similar to quicksand in a bubbling spring, and it is through this mass of hindering quicksand that the classified particle must make its way, first by forming part of the quicksand, then working to the bottom, gravity exerting greater force upon it than the rising current of water, and finally dropping through the discharge bushing. During the period in the quicksand sorting column the particle is thoroughly washed, and the velocity of the rising water is automatically maintained constant by and through the whole mass, eliminating all particles under standard.

RICHARDS' HINDERED SETTLING

As will be noted from the illustrations this classifier is composed of two elements: the box or tank into which the feed is received and over the end of which the material

Plate 10236

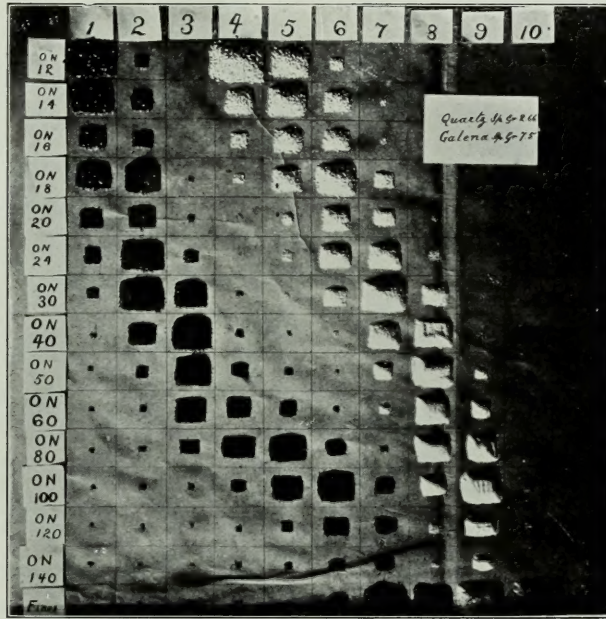


FIG. 5. HINDERED SETTLING

too light to enter the spigots flows, and the hindered settling chambers or spigots which are attached to the bottom of the box.

Plate 10165

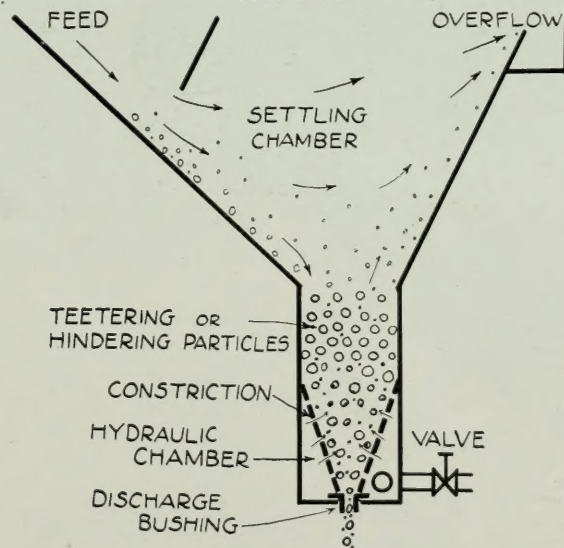


FIG. 6

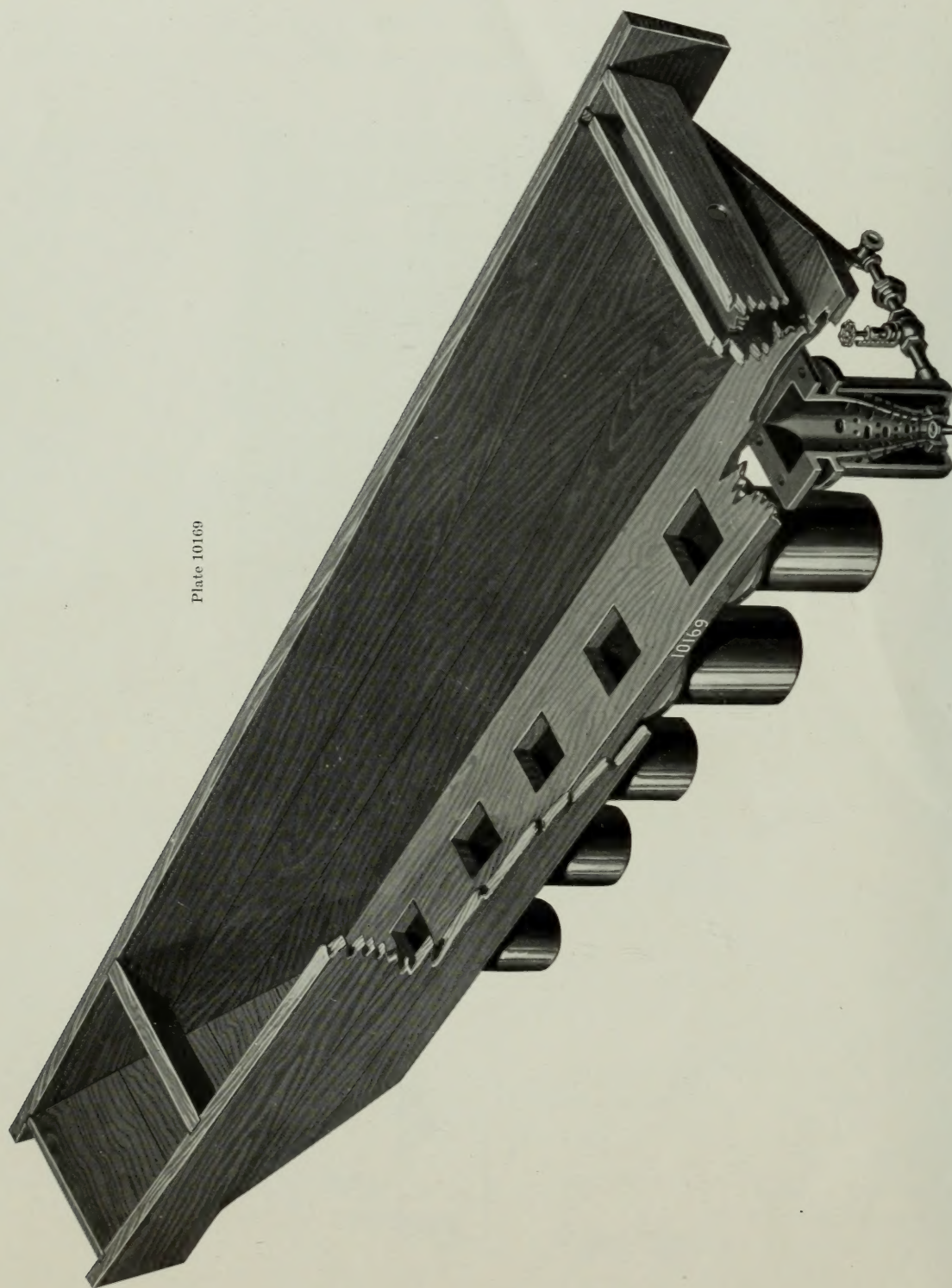


Plate 10169

SECTIONAL VIEW OF RICHARDS' HINDERED SETTLING CLASSIFIER
(Patented)

The box is made of wood or steel, usually the former, and is in the shape of the spitzkasten or a frustrum of an inverted pyramid, having a sloping bottom increasing in width and depth toward the overflow end; a baffle is placed across the top at the feed end to evenly distribute the feed and to break up plunging currents; the overflow at the lower end carries off all rejected pulp; a plugged hole is placed at the lower end just above the bottom line of the tank for the purpose of discharging any unclassified sands lodging there too large to be lifted by the rising current in the tank.

The cast iron spigot is in two parts, one, the cylindrical hydraulic chamber on the outside tapped for the pipe which brings in the water for the rising current, the other, the hindered settling diaphragm in which the final classifying takes place, and which forms the required constriction. In our latest type this diaphragm is in the form of a cone pierced by alternating rings of radial and tangential holes, through which the rising water passes from the hydraulic chamber, forming alternating radial and vortex jets within the cone which breaks up any possible agglomeration of particles and eliminate the possibility of harmful currents. In the cone the maximum rising current occurs at a point about one-third the distance up from the point of the cone, the current gradually diminishing toward the top of this chamber, which is filled with teetering or hindering particles, discharging at the bottom only as the weight becomes greater than the rising current can support.

The discharge, because of the hindered settling and coming from the apex of the cone, leaves the chamber with one-third to one-fifth the water that would be discharged from the ordinary free settling classifier. Where hindered settling classifiers are operating under the conditions for which we have designed them, the **water consumption** is found to be from **one-third to one-half gallon per minute** per ton of ore discharged per 24 hours, approximately 500 to 700 gallons per ton of ore. Thinner pulp can be discharged if required.

The repairs for this classifier amount to practically nothing, there being no moving parts to wear out. When the water contains copper in solution or considerable acid we can furnish metal parts of acid-resisting bronze; it is rarely necessary to use such material, and it will be found more economical to use new castings when renewals are required.

For the close regulation of rising water in the classifier some form of valve is necessary which can readily be set at a definite opening. For this purpose we recommend our indicating valve with micrometer attachment, Figure 7, on which the exact number and fraction of turns that the valve is open can be read at a glance. This valve can be furnished in the straight-way gate or globe types, and in the angle and cross forms as well.

CLASSIFIER SPIGOTS ATTACHED TO LAUNDERS

By increasing the number of spigots in a classifier, the feed going to each concentrating machine may be more closely controlled and greater efficiency obtained. The obviously ideal system is to have one classifier for each machine (or a pair of machines as shown in Figure 8), the two working together as a unit, controlling the quantity of the feed as well as its sizes at the classifier, and practically eliminating distributing boxes. This

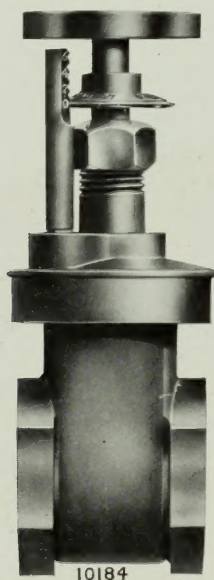


FIG. 7

scheme has worked out nicely in a few plants, notably at the mill of the Miami Copper Co., at Miami, Arizona, where, under the supervision of H. Kenyon Burch, individual Richards' Hindered Settling spigots are attached to boxes on the launders, each serving two concentrating machines. This gives an evenly flowing feed closely classified between narrow limits without excess water, and brings about the closest saving and greatest capacity possible.

The absence of long launders between the classifier and the concentrator allows the pulp to be delivered to the latter in the best possible condition for concentrating; the absence of mechanical drive makes this classifier very easy to attach to the launder, the only connection being that to the water system.

Plate 10182

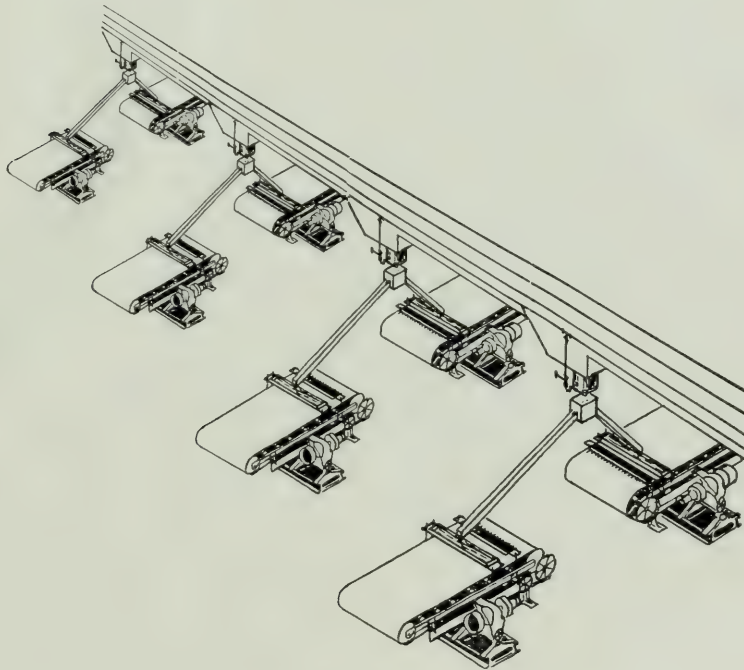


FIG. 8. LAUNDER CLASSIFICATION

HYDRAULIC CLASSIFICATION VS. SCREEN CLASSIFICATION

These two methods of preparing ore pulps have definite value in ore-dressing; they should be regarded as supplementary to each other rather than as rival methods. For concentration by jigging, which is similar in its general laws to hydraulic classification, screen sized feed gives the best results usually.

When we come to the finer sizes on which the jig fails to give efficient results, we find that the concentrating action on the surface machines used depends upon other principles than those underlying jigging, and different preparatory treatment is necessary. Screen sized feed is much better for table work than mixed or poorly classified feed, but the maintenance and attendance upon fine screening machines increases the cost per ton treated much more than any classifier, good, bad or indifferent. The fact that there is a partial sizing action upon the surface machine obviates the necessity for the screening, and makes it more advantageous to work upon material classified according to hydraulic laws.

In any process involving a separation of two articles having different properties, it may be stated that double treatment by the same process is not as efficacious as two separate treatments by different processes. In fact, there will be found certain hydraulic classifier products on which as good or better separation could be made using screening machines as by using any of the surface concentrating machines.

Good classification continuously maintained is one secret of successful concentrating operation. Classifiers must make a distinct separation and must be dependable if the large tonnages necessary to present day practice are to be maintained. Often machines or devices are installed as classifiers which do not make distinct separations, thus throwing the burden of the concentration upon the machines following, which become overloaded, and loss of values or of tonnages is the natural result. There is a principle which all millmen aim to practice: to save the values just as early in the game as practicable; if the pulp be well classified it is already partially saved, because the machines following are thereby better enabled to save it.

Every principle of successful business and of scientific milling points to the value of hydraulic classification in concentration. The increased advantages of hindered settling and the small cost of installation of our Richards' Hindered Settling Classifiers warrant their use in every concentrating plant, as a new installation, or replacing others which do not give the results demanded by the best practice of the day.

Our hindered settling classifiers are built to fit specific requirements and those contemplating changes in their system of classification will do well to consult with our engineers who will be pleased to make recommendations to fit the requirements. Before making recommendations we should know:

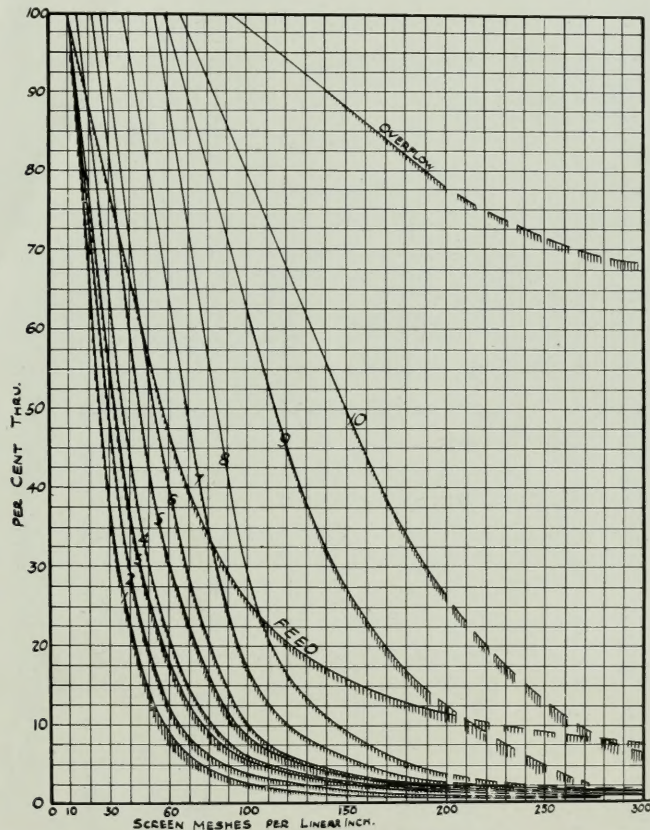
1. Tonnage of dry ore to be classified, per hour or per day.
2. Screen analysis of this feed.
3. Number and type of concentrating machines to be served.

RICHARDS' HINDERED SETTLING

4. Number of classified products desired.
5. Quantity of water in feed.
6. Mineral contents of various screen sizes.

Numbers 1 and 2 should be stated as exactly as possible; Numbers 3 and 4 should be stated if already installed or decided upon, if not installed our recommendations would be of value in determining these points; Numbers 5 and 6 would assist us in designing a classifier more closely meeting your requirements.

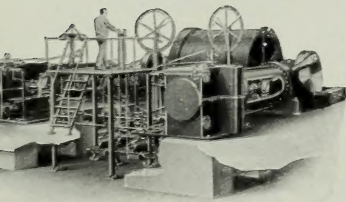
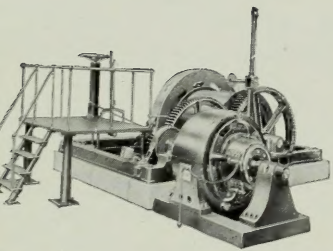
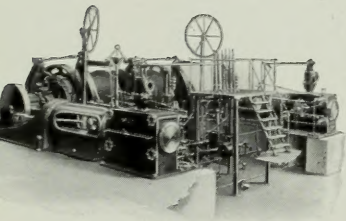
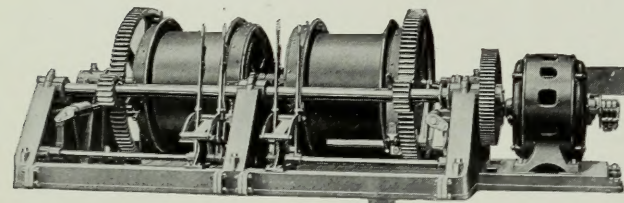
Plate 10167



RICHARDS' H. S. CLASSIFIER—SPIGOT PRODUCTS.
 SCREEN ANALYSIS OF FEED, OVERFLOW AND SPIGOT DISCHARGES OF
 A SERIES OF TEN HINDERED SETTLING SPIGOTS ATTACHED TO
 LAUNDER AT MIAMI COPPER COMPANY'S MILL, MIAMI, ARIZONA
 —SHADING INDICATES PROPORTION OF COPPER IN THE SCREEN SIZES OF PRODUCTS

RICHARDS' H. S. CLASSIFIER—SPIGOT PRODUCTS

HOISTING PROBLEMS—



Bulletin No. 1803 on Corliss hoists and bulletin No. 1445 on electric hoists are well worth your careful perusal.

Write to our nearest District office for copies.

1806

To plan for the future and still insure fair efficiency for the present, to keep down first costs and not increase depreciation, repairs or labor expense, to install the type or system that will prove efficient under all of the circumstances likely to arise, are among the conditions which must be considered in solving hoisting problems.

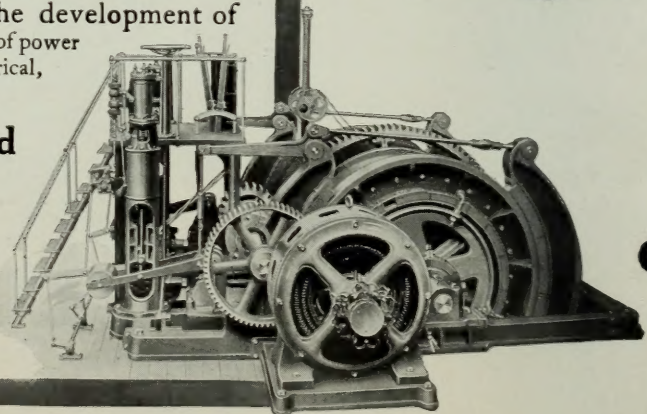
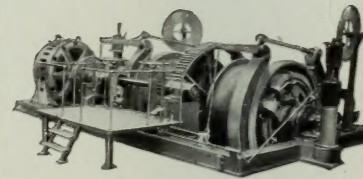
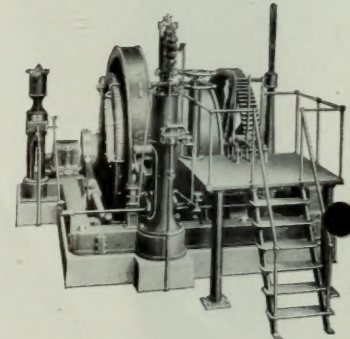
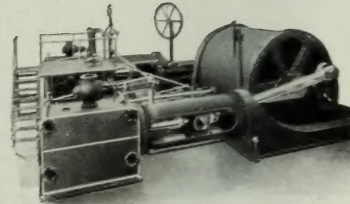
Some time or other every mine management has one of these problems and to meet it correctly often requires a knowledge of conditions foreign to the experience gained with their own equipment.

The best policy for any user of hoisting apparatus before determining upon the character of the equipment to be installed is to consult the records of the manufacturer who has studied and designed hoists for all conditions.

The greatest fund of information on hoisting problems is to be found in the records of Allis-Chalmers Manufacturing Company, which for the last half century has led in the development of hoisting as well as all types of power equipment:—Steam, Electrical, Air, Gas and Hydraulic.

Secure Unbiased Advice

regarding the equipment best adapted to your peculiar conditions by taking advantage of Allis-Chalmers Manufacturing Company's experience.



Allis-Chalmers Manufacturing Company's

PRINCIPAL PRODUCTS

AGRICULTURAL MACHINERY

Farm Tractors
Rotary Soil Tillers

AIR BRAKES

AIR COMPRESSORS

Steam Driven
Belt Driven
Electrically Driven, Portable
Electrically Driven, Stationary
Hydraulic Driven

CEMENT MACHINERY

Ball Mills
Ball Tube Mills
Balls, Forged
Crushing Rolls
Elevators
Feeders
Gyratory Breakers
Hoists
Mixing Pans
Perforated Metals
Revolving Screens
Rotary Coolers and Dryers
Rotary Kilns
Tube Mills
Tube Mill Linings
Tube Mill Pebbles

COAL MINING MACHINERY

Barney Cars
Crushing Rolls
Hoisting Cages
Revolving Screens
Shaking Screens
Ventilating Fans

CONDENSERS

Barometric
Jet
Surface

CRUSHING MACHINERY

Ballast Plants
Crushing Rolls
Dumping Skips
Elevators
Gyratory Breakers
Jaw Crushers
Macadam Plants
Perforated Metals
Portable Crushing Plants
Revolving Screens
Quarry Cars

ENGINES

Corliass Engines
Gas Engines
Diesel Oil Engines
Blowing Engines
Rolling Mill Engines

FORGINGS

PERFORATED METALS

FLOUR MILL MACHINERY

Aspirators
Bolters, Universal
Bolting Cloth
Bolting Cloth Cleaners
Bran and Shorts, Dusters
Bran Packers
Conveyors, Spiral
Corn Mills
Fans
Feed Mills
Feed Screens
Flour Dressers
Flaking Machines
Flour Feeders and Mixers
Flour Packers
Granulators
Purifiers
Reels
Rolls
Roller Mills
Rolling Screens
Scalpers

HOISTS

Electric Driven
Steam Driven

HYDRAULIC MACHINERY

Francois Turbines
Impulse Wheels
Oil Pressure Governors
Pressure Regulators
Accessories

MANGANESE BRONZE CASTINGS

MINING MACHINERY

Amalgam Appliances
Chilian Mills
Concentrating Plants
Conveyors
Copper Converting Plants
Cyanide Plants
Elevators
Frue Vanners
Gold and Silver Mills
Gyratory Breakers
Huntington Mills
Jaw Crushers
Jigs
Lead Refining Plants
Mine Ventilating Machinery
Mortar Mills
Ore Buckets
Ore Feeders
Prospecting Mills
Roasting Furnaces
Sampling Plants
Skips
Smelting Machinery
Stamps, Atmospheric
Stamps, Gravity
Stamps, Steam
Tube Mills, Wet and Dry

POWER TRANSMISSION MACHINERY

Belt Tighteners
Boxes
Couplings
Gears
Hangers
Pulleys
Rope Sheaves
Shafting

PUMPING MACHINERY

Centrifugal Pumps
Fire Service Pumps
Geared Pumps
"High Duty" Pumping Engines
Hydraulic Transmission Pumps
Screw Pumps

ROLLING MILL MACHINERY

SAW MILL MACHINERY

Band Mills, Double Cutting
Band Mills, Single Cutting
Band Mills, Telescopic
Band Re-saws, Horizontal
Band Re-saws, Vertical
Board Lifters, Steam
Cant Flippers, Steam
Canting Machine, Overhead
Carriages
Circular Saw Mills
Conveying Machinery
Cutting Off Saws, Steam Feed
Edgers
Edging Grinders
Feeds, Steam, Direct Acting
Feeds, Steam, Twin Engine
Filing Room Tools
Lath Mills and Bolters
Live Rolls and Drives
Log Chains
Log Jacks
Log Loaders
Log Turners
Niggers, Steam
Set Works
Slashers
Steam Feed Valves
Stock Lifters, Steam
Transfers
Trimmers

SUGAR MACHINERY

TIMBER TREATING AND PRESERVING MACHINERY

TURBINES—STEAM

TURBINES—WATER

ELECTRICAL APPARATUS

ALTERNATING CURRENT GENERATORS AND MOTORS

Belted Type Generators
Engine Type Generators
Fly-wheel Type Generators
Turbo Generators

Water-wheel Type Generators
Synchronous Frequency Changers
Induction Motor Frequency Changers

Synchronous Motor-Generator Sets
Induction Motor-Generator Sets
Synchronous Motors
Synchronous Condensers

Induction Motors
Transformers
Rotary Converters

DIRECT CURRENT GENERATORS AND MOTORS

Belted Type Generators
Engine Type Generators

Small Bipolar and Multipolar Motors and Generators
Electric Railway Equipments, Motors, Controllers, etc.

Multiple Voltage Balancing Sets
Multiple Voltage Variable Speed Equipments

SWITCHBOARDS FOR DIRECT CURRENT AND ALTERNATING CURRENT

ALLIS-CHALMERS MANUFACTURING COMPANY

Allis-Chalmers Manufacturing Company

General Offices, Milwaukee, Wis.

DISTRICT OFFICES

Atlanta, Ga., 1104 Healey Bldg.
 Boston, Mass., 50 Congress St.
 Buffalo, N. Y., Ellicott Square Bldg.
 Chicago, Ill., Peoples Gas Bldg.
 Cincinnati, O., First National Bank Bldg.
 Cleveland, O., Schofield Bldg.
 Dallas, Texas, Sumpter Bldg.
 Denver, Colo., First National Bank Bldg.
 Detroit, Mich., Ford Bldg.
 Duluth, Minn., Alworth Bldg.
 El Paso, Texas, 2900 San Diego St.
 Indianapolis, Ind., 516 Traction Terminal Bldg.
 Kansas City, Mo., Waldheim Bldg.

Los Angeles, Cal., Title Insurance Bldg.
 Milwaukee, Wis., West Allis Works
 Minneapolis, Minn., Corn Exchange Bldg.
 New Orleans, La., Maison Blanche Bldg.
 New York, N. Y., 50 Church Street
 Philadelphia, Pa., 903 Pennsylvania Bldg.
 Pittsburgh, Pa., 1209 Park Bldg.
 Portland, Ore., 92 First St.
 St. Louis, Mo., Railway Exchange Bldg.
 Salt Lake City, Utah, Kearns Bldg.
 San Francisco, Cal., Rialto Bldg.
 Seattle, Wash., 115 Jackson Street
 Toledo, O., Ohio Bldg.

FOREIGN DISTRICT OFFICES

London, England, 732 Salisbury House, London Wall, E. C.
 Santiago, Chile, Huerfanos 1157, Casilla 2653.

CANADIAN REPRESENTATIVES

Canadian Allis-Chalmers, Limited: Toronto, Ont.

FOREIGN SALES AGENCIES

Auckland, New Zealand,	John Chambers & Sons, Ltd.
Bombay, India,	Marshall Sons & Co.
Buenos Aires, Argentine Republic,	American Trading Company
Calcutta, India,	Marshall Sons & Co.
Honolulu, Hawaii,	Honolulu Iron Works
Ipoh, Federated Malay States,	McAlister & Co., Ltd.
Johannesburg, South Africa,	Herbert Ainsworth
Kobe, Japan,	American Trading Company
Manila, Philippine Islands,	American Trading Company
Paris, France,	R. Sequin
Perth, West Australia,	Frank R. Perrot
Rio de Janeiro, Brazil,	American Trading Company
Petrograd, Russia,	International Engineering & Trading Co.
Shanghai, China,	American Trading Company
Singapore, Straits Settlements,	McAlister & Co., Ltd.
Sydney, Australia,	Frank R. Perrot
Sydney, Australia,	Standard-Waygood, Ltd.
Yokohama, Japan,	American Trading Company